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OCCASIONAL
PAPER

Untying Gulliver

Taking Risks to Acquire Novel Weapon Systems

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Prepared for the Office of the Secretary of Defense

RAND NATIONAL DEFENSE RESEARCH INSTITUTE

The research described in this report was prepared for the Office of the Secretary of Defense (OSD). The research was conducted in the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community under Contract W74V8H-06-C-0002.

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Preface

Today's defense environment is placing growing pressure on defense policymakers to be nimble and adaptive, particularly with respect to acquisition systems and processes. This occasional paper is one in a series drawing upon the expertise of core RAND Corporation staff to explore issues and offer suggestions on topics that are likely to be of critical importance to the new leadership: the use of competition, development of novel systems, prototyping, risk management, organizational and management issues, and the acquisition workforce. The papers are designed to inform new initiatives for markedly improving the cost, timeliness, and innovativeness of weapons systems that the Department of Defense (DoD) intends to acquire.

This paper argues that the standard weapon-system acquisition policy and processes are simply too risk-averse to enable the effective development and employment of novel systems concepts that involve some combination of true urgency and considerable uncertainties. Further, an acquisition strategy for developing novel systems cannot hinge on achieving precise cost, schedule, and performance outcomes. We define novel systems and describe their special features, and then outline the major elements of an acquisition strategy that would be more consistent with the special features of novel systems and with the expected environment of urgency that might attend their development.

This study was sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD–AT&L)) and conducted within the Acquisition and Technology Policy Center of the RAND National Defense Research Institute, a federally funded

research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community.

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Untying Gulliver

Introduction

Traditionally, the defense acquisition system equips relatively large forces for major combat operations involving weapon systems that are produced in significant quantities and intended to be operational for decades. However, today there is a growing need to equip smaller forces to respond to asymmetrical threats using novel weapon systems that can be quickly developed and fielded.

Novel systems—often an integration of several known technologies, coupled with doctrinal and organizational changes—have more uncertainty when compared to traditional acquisition programs, and they present a challenge to the traditional acquisition process. Acquisition policies and procedures in place today are designed to deliver new systems based on a stable design to minimize risk. However, to quickly field innovative and novel systems, the acquisition community must accept precisely the uncertainties and risks that the traditional acquisition process has been deliberately designed to avoid.

The aversion to risk that is built into the current acquisition process impedes rather than encourages the development of novel systems, especially those based upon disruptive rather than evolutionary technology. Although DoD has established a number of organizations and undertaken numerous initiatives to manage the identification, test, and deployment of novel systems,[1] creating

[1] Examples include the Joint Rapid Acquisition Cell, the U.S. Army's Rapid Equipping Force, the Director of Defense Research and Engineering's Rapid Reaction Technology Office,

capabilities in the absence of any expressed warfighter need—that is, "technology push"—continues to run too much against the political, bureaucratic, and regulatory grain of the defense acquisition process. If it is allowed to continue, this aversion will have serious consequences for the long-term quality and capability of future U.S. combat forces. As near-term budget pressures and force modernization needs mount, spending scarce resources on capabilities that *might* become available or that *might* produce fundamental changes in mission capabilities is understandably viewed with little enthusiasm. Creating an environment that fosters innovation and novel system development is one of the tough, but fundamental challenges facing senior leaders in DoD.

An acquisition strategy for developing novel systems cannot hinge on achieving precise cost, schedule, and performance outcomes.

This paper argues that fostering innovative systems requires a separate acquisition strategy that

- focuses on technology push and unique integrations of existing and emerging technologies;
- emphasizes flexibility, including an overt willingness to accept risks;
- allows easy and quick termination of programs not yielding expected benefits;
- enables early test and demonstration of military utility.

In other words, we argue that fostering innovative systems requires a strategy that is more streamlined and less tied to achieving precise estimated cost, schedule, and performance outcomes in order to provide improved or unique capabilities to the warfighter as quickly as possible.

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the Defense Advanced Research Projects Agency, the U.S. Air Force's Quick Reaction Cell, the now-closed Air Force battle labs, Big Safari, et cetera.

In this paper, we will first define what we mean by novel systems and describe their special features, and then we will outline the necessary elements of a strategy for developing these systems.

What Is a Novel System?

Novel systems differ from legacy or conventional systems on several dimensions: design, operational employment, outcomes, production run, and operational life. Figure 1 compares novel systems to conventional systems in terms of these dimensions (the descriptive adjectives used are deliberately simplified in order to emphasize the extent of the differences).

Conventional systems—for example, the Joint Strike Fighter, the F-22 fighter, and the Navy's new destroyer, DD(X)—may contain the latest technologies, but this alone does not constitute a "novel system." We know how to classify conventional systems (e.g., tactical aircraft, surface combatant); we know how we are going to use them; they fill an official capability gap; and we know about how many we plan to buy.

On the other hand, in novel systems—such as the F-117 Stealth Fighter, novel mine-counter measures, and robotic ground vehicles—the following factors are less certain:

Figure 1
Comparison of Conventional and Novel Systems

Conventional Systems	**DIMENSIONS**	*Novel Systems*
Follow-on	**Design**	*New*
Evolutionary	**Technology**	*Disruptive*
Established	**Operational employment**	*In formulation*
Predictable	**Outcomes**	*Uncertain*
Large	**Production run**	*Uncertain*
Long	**Operational life**	*Uncertain*

- The design of a novel system is new in overall concept or in integration of existing/use of emerging technologies, or both, so that the development outcomes (mainly performance and cost) cannot be confidently predicted on the basis of studies alone.
- The operational employment doctrine has not been clearly defined and demonstrated and is therefore subject to substantial uncertainties and change.
- The eventual size of the production run and the subsequent operational life are uncertain (an obvious consequence of the uncertainties surrounding the cost, capabilities, and operational concept of the system).
- The nature of the key uncertainties is such that they can be resolved only through development and test of a system or through prototypes, hopefully at a cost that is commensurate with the potential value of the system.

The case of unmanned aerial systems (UASs) during the 1980s and early 1990s illustrates many of these characteristics. It had been technically possible to build generic UAS platforms for several decades, and many had been built and used as aerial targets and reconnaissance drones. Throughout that period, various combat and combat-support roles had been posited for UASs, but every proposed application raised a host of troublesome issues: exactly how would UASs be controlled, especially in situations demanding deviation from the original mission plan? How would the information normally obtained visually by the pilot be acquired and translated into mission-relevant decisions? How would safety be ensured during peacetime operations over populated areas? And so on. Despite many studies and a small number of actual development projects that were canceled early, few UAS programs were actually completed in the United States during this time. How can we explain this? A 1997 study (Sommer et al., 1997) suggested a range of possible factors.

Novel systems involve uncertainty not only with regard to design, but also in terms of operational employment and possible outcomes.

> The cause of the poor track record of UAV[2] programs in the United States is not entirely clear. Certainly, the mere fact of their being *unmanned* vehicles cannot be the cause. After all, the United States has had great success with other unmanned systems, ranging from interplanetary spacecraft and satellites to cruise missiles and submersibles. What, then, makes UAVs unique? A possible explanation is that UAVs in general have never had the degree of operational user support necessary to allow their procurement in sufficient quantities (perhaps because of funding competitions from incumbent programs, or because of the conjectural nature of their capabilities). Thus, the learning curve is never ascended, multiple failures occur, risk tolerance decreases, unit costs rise as a result, and user support decreases yet further in a diminishing spiral.

In addition to these factors, the acquisition process itself (as defined in DoD's 5000 series of directives) is simply not congenial to programs with a range of important uncertainties. A key problem in developing novel systems lies in the sequence of decisions and actions involved in the defense acquisition process. Early on, when DoD is trying to decide how to fill a capability gap, a series of studies are performed, followed by a Milestone A decision, at which point the system concept to be developed is clearly defined and the sponsor commits to funding for development and initial production. In the case of novel systems, major uncertainties and risks are not likely to be adequately resolved at this milestone; thus, the acquisition process eliminates them from further consideration. The funding needed to explore and resolve the major uncertainties generally exceeds that which could be obtained by a project, unless it is directly coupled with a major acquisition program. Thus, uncertainties are unresolved, and progress is stifled.

Major uncertainties in novel systems generally will not be resolved by Milestone A; this means they are eliminated from further consideration.

[2] Unmanned aerial systems (UASs) were formerly called unmanned aerial vehicles (UAVs).

In the commercial world, some of the most successful products are ones consumers never knew they needed until they came on the market—iPods, cell phones, digital cameras, Blackberries, GPS navigation systems, Bluetooth headsets, et cetera. To achieve these breakthroughs, businesses accept a greater amount of risk in developing some of their product lines.

A Strategy for Fielding Novel Systems Concepts

The characteristics of novel systems are so different from those of the systems for which the present acquisition process was designed that we believe "tinkering" with the present process is impractical. To formulate more appropriate procedures, we identify major elements of an acquisition strategy that would be more consistent with the special features of novel systems and with the expected environment of urgency that might attend their development.

A new strategy is needed to oversee development and demonstration of novel systems.

Provide an Environment That Fosters New Concepts for Systems and New Concepts of Operations. To provide a rich source of new options to address emerging threats in a timely manner, DoD needs (1) staff who combine both technical and operational experience and skills and (2) a culture in which innovation is constrained only by perceptions of technical feasibility and relative operational value compared to other innovative investment ideas, not by current doctrine on force composition and employment.

Monitor Civilian Technologies That Could Be Integrated in Unique Ways to Give Warfighters New Capabilities.[3] This second element is

[3] The idea of a single technological breakthrough, while popular, is belied by fact. Advances have not come with the introduction of a spectacular new technology, but with the integration of several known and often rather mundane existing technologies.

needed because the level and scope of the private sector's investment in fast-moving commercial technologies outpace DoD's efforts to shape the marketplace. Integrating and morphing commercial technologies into unique and new warfighting capabilities should be opportunity driven, rather than need driven, as is currently the case.

Upon Successful Demonstration of a New System, Permit Early, Provisional Fielding and Operation Before Completion of Full Maturation Development and Associated Testing. The third element of the strategy focuses on the later phases of acquisition. Today's acquisition procedures demand (1) extensive effort toward system maturation to minimize support costs, together with (2) extensive operational testing to ensure that no significant lingering problems and deficiencies exist. The interrelationships of funding, testing, and buying hardware that occur at this point should be examined with the objective of relaxing their interdependency. Delinking funding approvals from testing status could allow a novel system to proceed through an appropriation threshold and would break the link with service "requirements." This delinking will reduce costs and project duration, getting the system to the warfighter sooner, but with less maturity than traditional systems.

Our most radical proposal—and most powerful tactic to acquire novel systems—is to delink funding, testing, and buying.

This element is the most radical one of the acquisition strategy recommended in this paper, and it poses the most challenging implementation problems, but it potentially contains the most powerful tactic for moving an innovative new system concept to early operational capability. To implement this element will require establishment of "experimental" operational units designed to receive and operate systems that are not quite technically mature, that are not fully provisioned with support and training aids, and that lie outside the main thrust of acquisition policy for traditional major defense acquisition programs.

Encourage Timely and Visionary Decisions on Novel Programs by Decreasing the Need for Extensive Staff Support and Documentation

and by Giving a Few Junior Officials More Authority for These Programs. The fourth element of the strategy is needed to remove the extensive and lengthy documentation and review procedures now required for milestone approval, especially at Milestone A. Those procedures were designed to ensure a full examination of all alternative concepts, to create a broad-based consensus on the selected concept and to manage risk. Such extensive documentation and reviews might make sense when the proposed new system concept is an extension of previous design concepts and operational employment strategies because a broad accumulation of experience and historical data are available. However, such accumulation of experience and corresponding data do not exist for novel systems concepts. Further, DoD may have put too much faith in senior officials to make judgments and decisions about concepts with which they and their staffs have little or no experience. Those officials operate in an environment that severely criticizes them for any unsuccessful project. Many of our current "rules" are designed to govern the perceived excesses of acquisition officials. Giving junior executing officers more flexibility and responsibility, while holding them accountable, may be a more realistic and more effective approach.

DoD will need to establish "experimental" operational units designed to receive and operate systems that are not quite technically mature.

Systematically Accumulate Lessons Learned About Managing the Development and Demonstration of Novel Systems and Operational Concepts. Almost without exception, novel systems have been conceived, designed, and developed outside of the conventional acquisition system. All of the services have a quick reaction capability that functions outside normal acquisition rules and focuses on very quickly fielding innovative concepts and novel systems. Similarly, DoD's Defense Advanced Research Projects Agency and, in the private sector, Lockheed Martin's Skunk Works and Boeing's Phantom Works have acquired extensive experience with novel systems.

The point is that there are people and organizations that have significant experience with technology development, cleverly integrating

existing technologies and making changes in tactics that can help DoD more effectively bring innovation and novel systems to warfighting. An in-depth, systematic analysis of successful as well as ineffective organizational and managerial attributes for fostering innovation in the absence of a competitive, free market would help DoD establish new organizations with explicit charters for experimentation, testing and learning, and demonstration.

Conclusions

Each of these elements has been applied in the past under special circumstances, with beneficial results—for example, in developing the F-117, sea-launched ballistic missiles, cruise missiles, and UASs. But "special case" applications hinder the systematic development of management expertise and effective management processes. Moreover, these applications were difficult to implement and transition to operational forces due to an acquisition environment that favors more detail about the end stages of a program than these mechanisms can provide.

Hence, we believe it appropriate and desirable to devise a less formal, less "standard" path for the acquisition of novel systems, based on the strategy outlined above. By understanding the environmental attributes to foster novel systems, DoD will signal that novel system ideas and concepts will be encouraged, and it will bestow a military advantage to U.S. warfighters as the first nation to develop and use them.

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